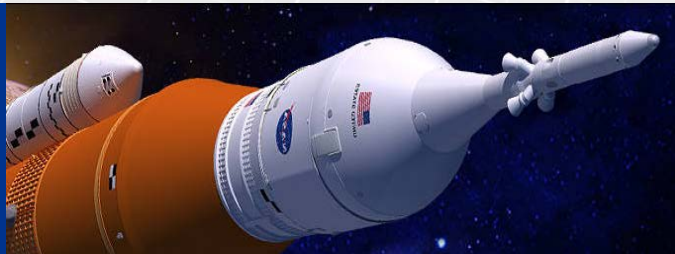


The Weather Analysis Display (WAND) Tool: Developing a Meteorological Data Display Tool for Situational Awareness during Day of Launch of Space Launch Vehicles Using Python

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Background

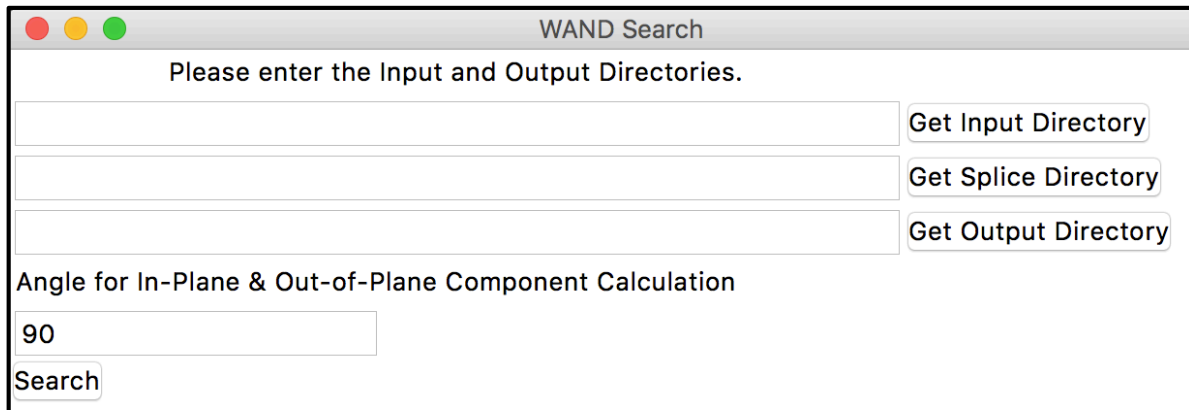
- Atmospheric environments are an important element in day-of-launch (DOL) operations of space launch vehicles.
- NASA Marshall Space Flight Center Natural Environments Branch provides multiple functions supporting DOL operations.
 - Generates a vertically complete profiles for trajectory and load calculations using the Profile Envision and Splicing Tool (Orcutt et al.; 2017)
 - Monitors atmospheric conditions for situational awareness



Weather Analysis Display (WAND) Introduction

- The USAF's Eastern Range contains of a highly dense network of weather instrumentation.
 - A network of weather towers
 - Weather balloons
 - A network of Doppler Radar Wind Profiling (DRWP) systems
 - Tropospheric DRWP at ~48-MHz
 - Boundary Layer Profilers at 915-MHz
- WAND was developed by MSFC NE to provide MSFC NE DOL operators situational awareness capability by presenting data in a multitude of ways.
 - Observations
 - Climatology
- Designed to operate within the “highly secured” environment at the Huntsville Operations Support Center.
 - WAND was coded using Python 3
 - Has few dependencies
 - Numpy – array handling
 - Scipy – mathematical functions
 - Matplotlib – data visualization
 - Tkinter – create and execute the Graphical User Interface (GUI)

WAND Design

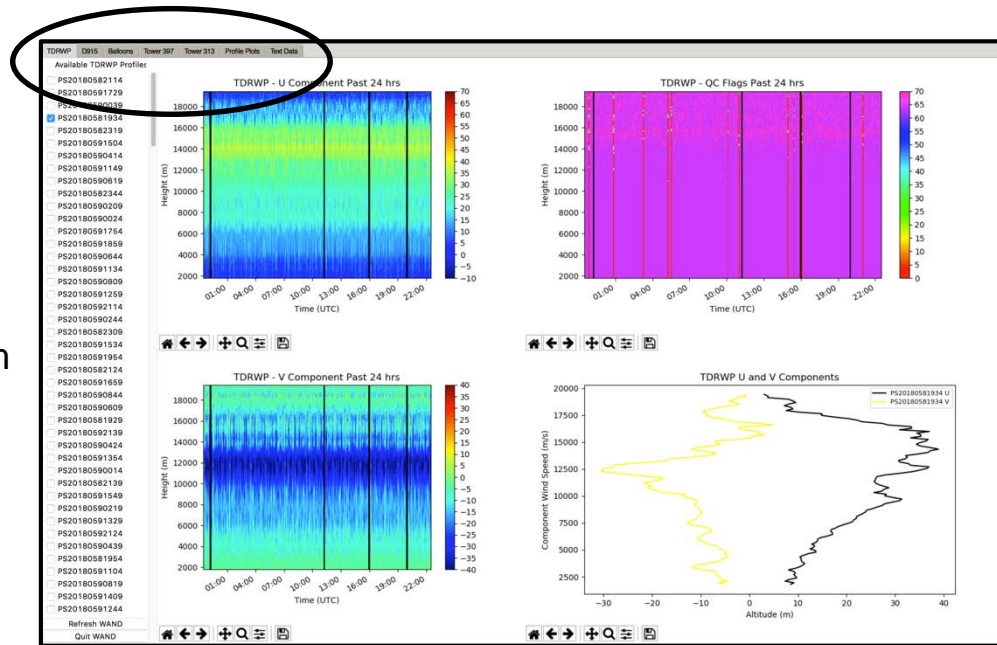


The screenshot shows a window titled "WAND Search" with a standard macOS-style title bar (red, yellow, green buttons). The main content area has a header text "Please enter the Input and Output Directories." Below this are three text input fields. To the right of each field is a button: "Get Input Directory", "Get Splice Directory", and "Get Output Directory". Below these fields is a label "Angle for In-Plane & Out-of-Plane Component Calculation" followed by a text input field containing the value "90". At the bottom left is a "Search" button.

- This window is the initial window that appears when WAND is started.
- Allows the operator to select the desired input and output directories as well as set the desired angle for in-plane and out-of-plane wind component calculations.
- Clicking the “Search” button once all directories are supplied will get WAND to search for any data from the past 24 hours.

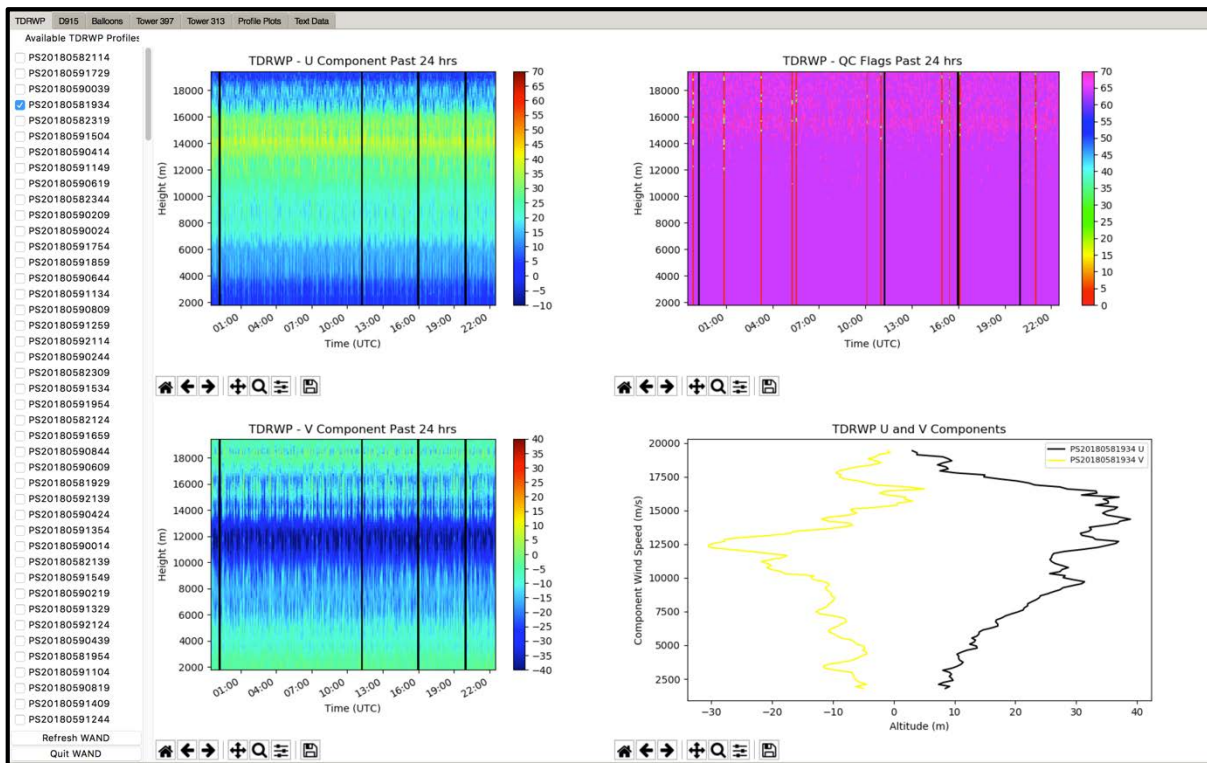
WAND Design

- WAND uses tabs to control which system is being displayed.
 - Tropospheric DRWP (TDRWP)
 - 915-MHz DRWP (D915)
 - Balloons
 - Tower 397 (located at the launch pad)
 - Tower 313 (located approximately 5 km from the launch pad)
 - Profile Plots
 - Text Data



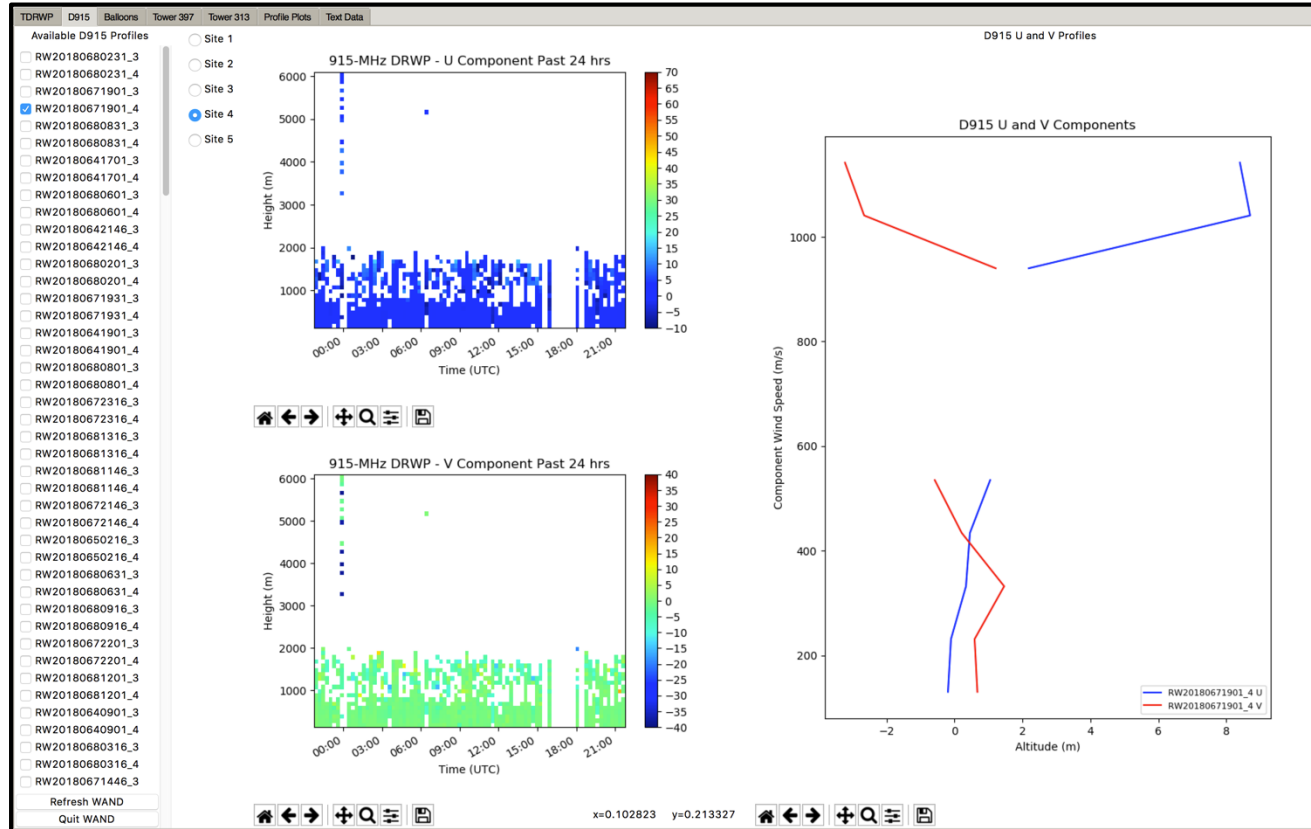
WAND Design

- WAND opens to the TDRWP tab.
- The TDRWP tab contains time-height cross-sections of the U and V wind components, the TDRWP's QC flags, and profile plots of U and V.



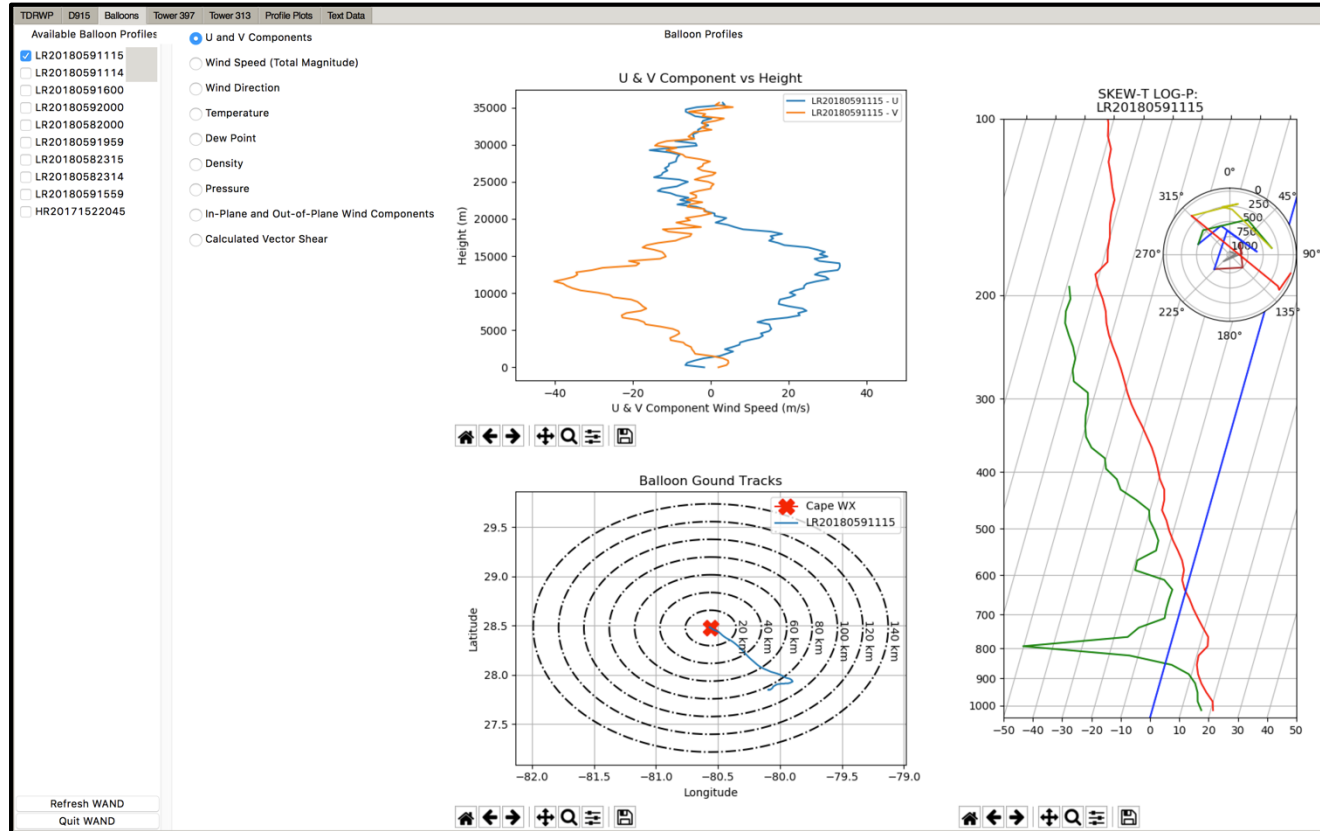
WAND Design

- The D915 tab is nearly identical to the TDRWP tab, but does not have a QC flag time-height cross-section plot.



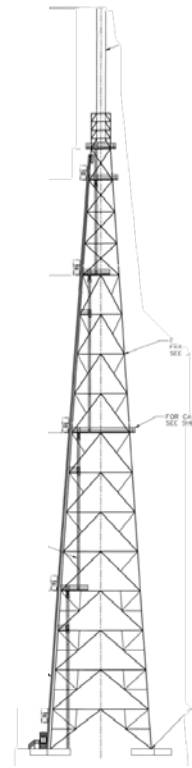
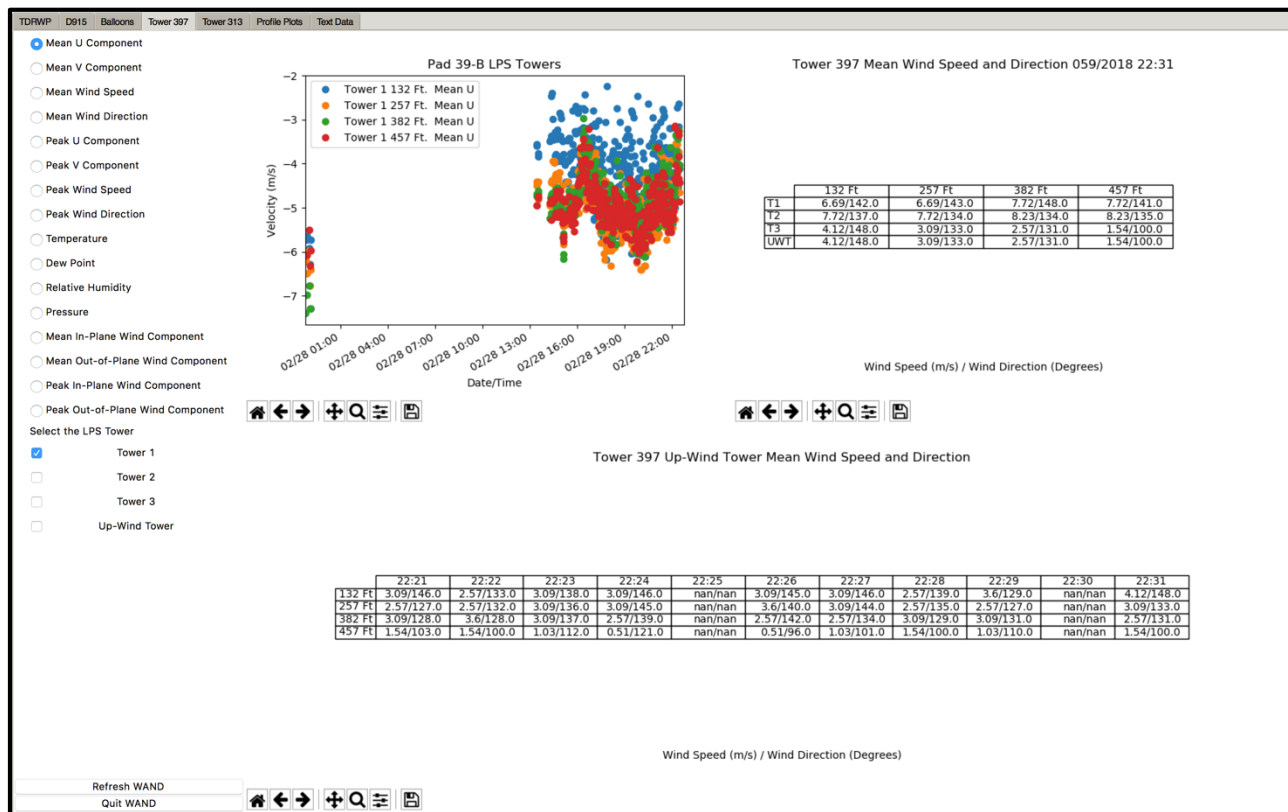
WAND Design

- The Balloons tab displays the vertical profile of all variables reported by the balloon systems, ground tracks of the balloons, and Skew-T Log-P.



WAND Design

- The Tower 397 tab displays a time series of any variable that is measured by the towers, a table of the current conditions from all sensors, and a table of time series of the past 10 minutes of data from the up-wind tower (Orcutt et al., 2016).



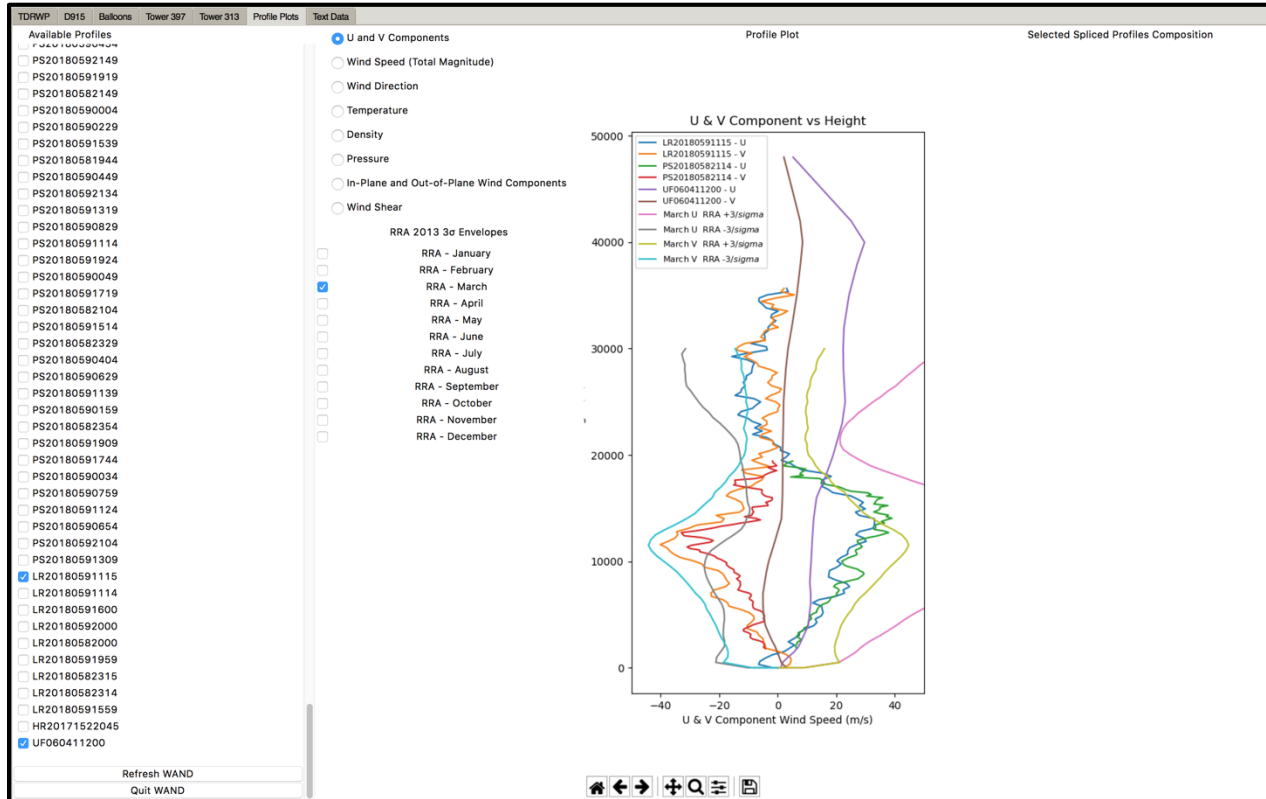
WAND Design

- The Tower 313 tab is identical in layout to the Tower 397 tab.



WAND Design

- The Profile Plots tab displays vertical profiles of any measurement from all of the DRWPs, balloons, Profile Envision and Splicing Tool (PRESTO) spliced profiles, upper level profiles, and statistical envelopes.



WAND Design

- The Text Data tab displays the selected data file as text.

TDRWP	D915	Balloons	Tower 397	Tower 313	Profile Plots	Text Data
Available Profiles						P5070582115 TEST NBR 02018 PROFILE DATA KENNEDY SPACE CENTER, FL. 2114Z 27 FEB 18
<input checked="" type="checkbox"/>	PS20180582114					ALT DIR SPD SHR WW S1 S2 S3 N1 N2 N3 WID1 WID2 WID3 G G QC GEOM DEG M/S /SEC M/S DB DB DB DB DB DB M/S M/S M/S 1 2 NN 1795 303 7.7 .000 -0.09118.9117.0118.0 57.9 58.3 58.1 0.7 0.5 0.62 0 0 64 1944 308 7.9 .004 -0.05116.2117.1116.6 57.8 58.2 58.0 0.8 0.5 0.65 0 0 64 2093 306 7.6 .002 -0.11120.6122.4121.6 57.4 57.7 57.6 0.6 0.5 0.56 0 0 64 2243 305 8.1 .004 -0.09123.8121.9123.0 57.9 58.3 58.1 0.8 0.5 0.64 0 0 64 2392 307 8.3 .003 -0.06119.6122.6121.4 58.7 59.1 58.9 0.6 0.5 0.53 0 0 64 2542 310 9.9 .011 -0.08114.2115.8115.1 59.2 59.4 59.3 0.4 0.5 0.46 0 0 64 2691 317 11.6 .015 -0.15102.8103.5103.2 59.9 60.2 60.1 0.6 0.7 0.66 0 0 64 2841 323 11.7 .008 -0.14106.3106.2106.3 60.1 60.2 60.2 0.6 0.7 0.65 0 0 64 2990 325 11.4 .004 -0.13103.7104.7104.3 60.1 60.2 60.2 0.7 0.6 0.65 0 0 64 3140 322 11.6 .003 -0.11100.5100.4100.5 60.1 60.2 60.2 1.1 0.6 0.87 0 0 64 3289 325 12.2 .006 -0.01 98.8100.0 99.4 60.0 60.1 60.1 1.0 0.8 0.88 0 0 64 3439 324 14.3 .014 0.01111.6113.2112.5 60.1 60.2 60.2 0.5 0.6 0.56 0 0 64 3588 323 14.7 .003 0.04114.0115.1114.6 60.1 60.3 60.2 0.5 0.6 0.56 0 0 64 3737 320 14.1 .006 -0.02110.0108.1109.2 60.1 60.3 60.2 0.5 0.8 0.66 0 0 64 3887 313 13.9 .011 -0.04112.1110.6111.4 60.1 60.2 60.1 0.5 0.7 0.58 0 0 64 4036 309 13.3 .008 -0.05109.5109.2109.4 60.1 60.2 60.1 0.6 0.7 0.63 0 0 64 4186 302 12.4 .011 -0.04107.2108.7108.0 60.0 60.1 60.1 0.6 0.5 0.55 0 0 64 4335 295 11.5 .012 -0.01110.0108.7109.4 60.1 60.2 60.1 0.5 0.5 0.52 0 0 64 4485 292 11.9 .005 -0.05109.9109.3109.6 60.0 60.2 60.1 0.5 0.4 0.45 0 0 64 4634 293 12.6 .004 -0.09106.8105.2106.1 60.1 60.1 60.1 0.5 0.4 0.43 0 0 64 4784 292 12.1 .004 -0.12111.7109.4110.7 60.0 60.1 60.1 0.6 0.4 0.46 0 0 64 4933 292 12.1 .000 -0.13110.7111.9111.3 60.1 60.1 60.1 0.6 0.3 0.49 0 0 64 5083 292 13.1 .007 -0.10102.5103.0102.7 60.0 60.1 60.1 0.8 0.5 0.65 0 0 64 5232 291 14.3 .008 -0.07106.8106.7106.7 60.1 60.1 60.1 0.6 0.6 0.61 0 0 64 5381 295 14.7 .007 -0.04108.8109.2109.0 60.0 60.1 60.1 0.5 0.7 0.61 0 0 64 5531 300 15.8 .012 -0.04107.0106.0106.5 60.0 60.0 60.0 0.6 0.6 0.60 0 0 64 5680 301 16.4 .004 -0.11104.2100.8102.8 60.0 60.1 60.1 0.5 0.6 0.58 0 0 64 5830 300 16.9 .004 -0.09 99.3 97.7 98.5 60.0 60.1 60.0 0.6 0.6 0.62 0 0 64 6070 290 17.7 .007 -0.10 06.7 04.0 06.1 60.1 60.1 60.1 0.6 0.6 0.63 0 0 64
Refresh WAND						
Quit WAND						

Summary

- MSFC NE developed a tool, WAND, using Python to provide DOL personnel with displays of the meteorological conditions at and around the launch site for situational awareness.
- WAND can display data from all systems at Kennedy Space Center and Cape Canaveral Air Force Station, as well as upper level wind forecasts and statistical envelopes.
- Forward work
 - Finish Formal Acceptance Testing

References

- Orcutt, J. M., J.C. Brenton. (2016) The Quality Control Algorithms Used in the Process of Creating the NASA Kennedy Space Center Lightning Protection System Towers Meteorological Database. Fifth Aviation, Range, and Aerospace Meteorology Special Symposium. New Orleans, LA, Amer. Meteor. Soc. P828.
- Orcutt, J. M., R.E. Barbré, J.C. Brenton, R.K. Decker. (2017) The Profile Envision and Splicing Tool (PRESTO): Developing an Atmospheric Wind Analysis Tool for Space Launch Vehicles Using Python. Seventh Symposium on Advances in Modeling and Analysis Using Python. Seattle, WA, Amer. Meteor. Soc.

Questions?

